Semi-Arid Woody Cover Species Classification using Multi-Temporal Remote Sensing Data

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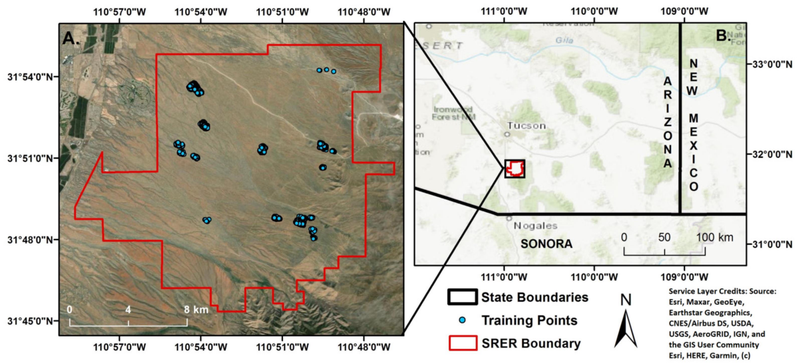
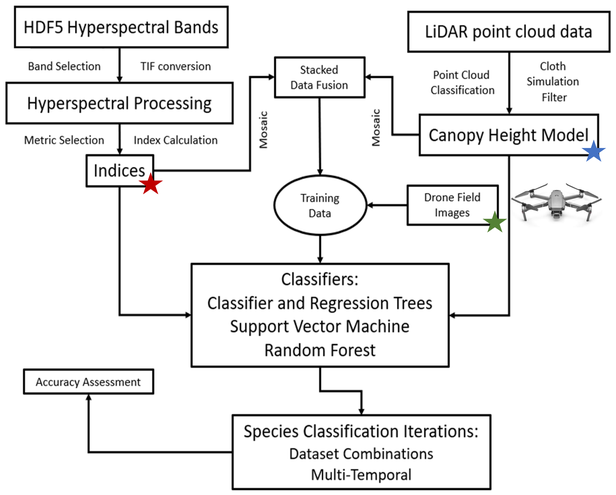
The Objectives were to create a framework for producing a species-specific woody vegetation map including five of the most abundant woody species in a large semi-arid region by utilizing a fusion of simultaneously acquired airborne LiDAR and high spatial resolution hyperspectral data to improve classification accuracies. Specifically, we will: (1) create spectral vegetation indices from hyperspectral reflectance bands, create canopy height models derived from raw LiDAR point clouds, and use the data for woody species classification, then (2) assess classifier performance and lastly (3) assess the classifier model, important metrics in the model, and training data combinations.

Location of Santa Rita Experimental Range (SRER), training points for the supervised species classification are symbolized in blue (**A**) and study area is outlined in red (**B**).



Methodology Flowchart includes hyperspectral and LiDAR processing, data fusion, and classification steps. Three years of data were clipped, mosaicked, and stacked to create overlapping raster stacks. This study produces highly accurate classifications by combining multi-temporal fine spatial resolution hyperspectral and LiDAR data (~1 m) through a reproducible scripting and machine learning approach that can be applied to larger areas and similar datasets



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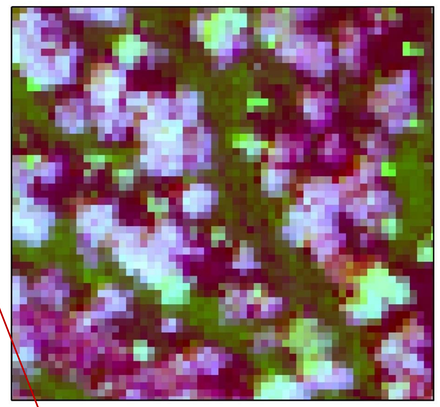
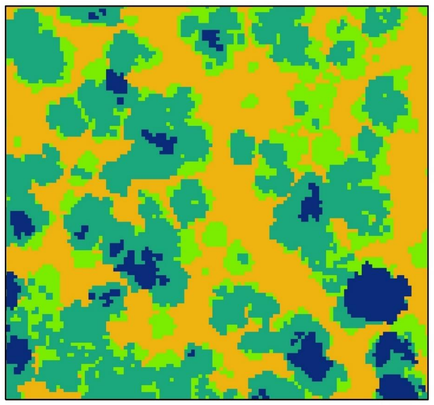
Drone Image ★

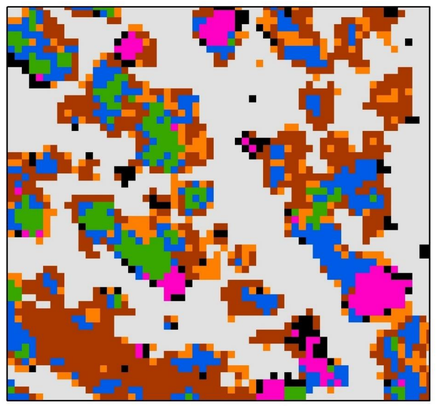
Indices Composite ★



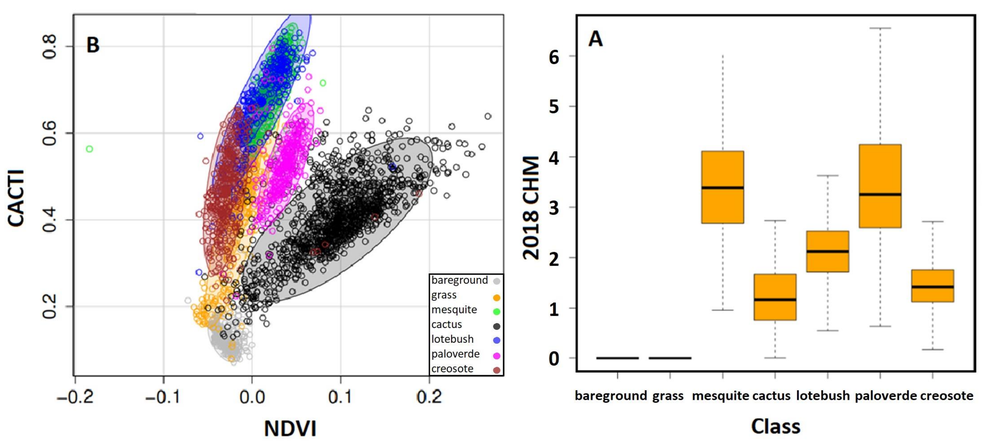
Canopy Height Model ★



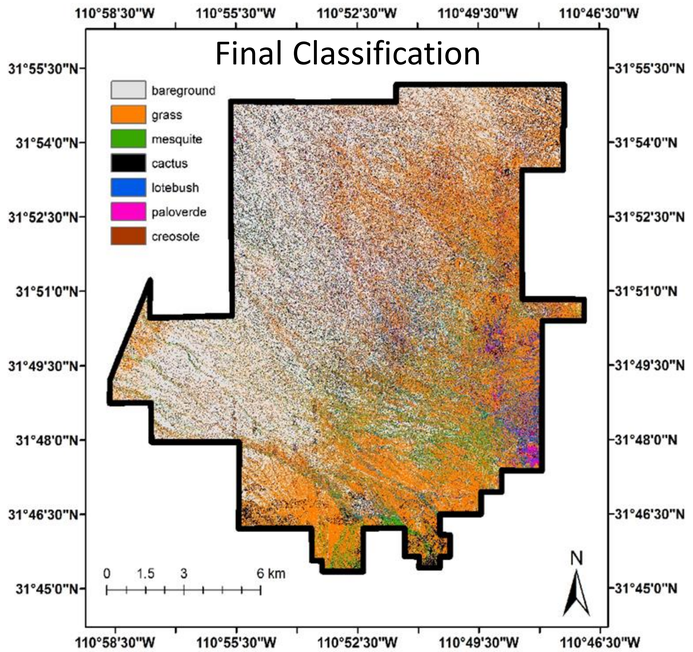
Final Classification



We collected high resolution **drone images** to help visually delineate tree species for the classifier. For additional visualization aid in training collection, we visualized images of a **canopy height model** (CHM) and an RGB **indices composite** of the Normalized Difference Vegetation Index, Cacti Index, and Soil Adjusted Vegetation Index to ensure correct species. Training and validation data for the classifier included various vegetation indices and canopy height models from years 2017, 2018 and 2019 .



(**A**) 2018 CHM differences and (**B**) 2019 CACTI and NDVI model with 95% confidence interval ellipses visualizing species delineation and legend indicating the color designated to each class. Adding a layer of LiDAR derived CHMs for quantification of tree height provided a unique way to delineate vegetation species. Utilizing both vegetation indices and CHM informed the classifier regarding different vegetation assets.



CONCLUSION

- Overall accuracy of 95.28% and kappa of 94.17%
- Five woody species were discriminated resulting in producer accuracies ranging from 86.12% to 98.38%
- The influence of fusing spectral and structural information in a random forest classifier for tree identification is evident
- A multi-temporal dataset slightly increases classification accuracies over a single data collection.
- Our results show a promising methodology for tree species classification in a semi-arid region using multi-temporal fine spatial resolution hyperspectral and LiDAR data (~1 m) through a reproducible scripting and machine learning approach that can be applied to larger areas and similar datasets.
- Next steps... apply methodology to different National Ecological Observatory Network (NEON) sites